Gravelless Drainfields

Recommended Standards and Guidance for
Performance, Application, Design and Operation & Maintenance

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Preface

The recommended standards contained in this document have been developed for statewide application. Regional differences may, however, result in application of this technology in a manner different than it is presented here. In some localities, greater allowances than those described here may reasonably be granted. In other localities, allowances that are provided for in this document may be restricted. In either setting, the local health officer has full authority in the application of this technology, consistent with Chapter 246-272 WAC and local jurisdictional rules. If any provision of these recommended standards is inconsistent with local jurisdictional rules, regulations, ordinances, policies, procedures, or practices, the local standards take precedence. Application of the recommended standards presented here is at the full discretion of the local health officer.

Local jurisdictional application of these recommended standards may be:

1) **Adopted as part of local rules, regulations or ordinances—**When the recommended standards, either as they are written or modified to more accurately reflect local conditions, are adopted as part of the local rules, their application is governed by local rule authority.

2) **Referred to as technical guidance in the application of the technology—**The recommended standards, either as they are written or modified to more accurately reflect local conditions, may be used locally as technical guidance.

Application of these recommended standards may occur in a manner that combines these two approaches. How these recommended standards are applied at the local jurisdictional level remains at the discretion of the local health officer and the local board of health.

The recommended standards presented here are provided in typical rule language to assist those local jurisdictions where adoption in local rules is the preferred option. Other information and guidance is presented in text boxes with a modified font style to easily distinguish it from the recommended standards.

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Introduction

The gravelless drainfields addressed in these standards represent several different types: pipe, chamber, gravel-substitute, and geocomposites. While the specifics of these types differ, their purpose is the same: meet (or exceed) the characteristics and function of gravel in a conventional gravel-filled drainfield. In a conventional gravel-filled drainfield the gravel is:

- non-deteriorating;
- provides void space (for the passage and temporary storage of septic tank effluent);
- presents an interface with the infiltrative surface—trench bottom and side-wall soil—(for absorption of the wastewater); and,
- maintains the integrity of the excavation, supporting the soil back-fill and cover.

The advantage of a gravelless drainfield becomes clear when and where suitable gravel is either unavailable, expensive, or where site conditions make moving gravel about difficult or time consuming. In addition to these benefits, the use of gravelless drainfields addresses some of the concerns presented with gravel. Among these are:

- The detrimental effect of gravel impacting and compressing the infiltrative surface when dumped into the drainfield trench from the front-end loader of a backhoe, which may lower the infiltrative capacity of the soil.
- If the quality of the gravel washing process is poor, the silt particles remaining on the surface of the gravel may be washed off when the drainfield is placed into use, resulting is a silt layer on the infiltrative surface, reducing its infiltrative capacity.
- The damaging effect that the transportation of gravel across yards can have on lawns, flowerbeds, shrubs, etc. due to the weight of the material and the size of the heavy equipment needed to effectively move it from the stock pile to the drainfield area.

Gravelless Drainfields—In addition to not using gravel, gravelless drainfields differ from the conventional gravel-filled drainfields in the following ways:

Gravelless Pipe—(See Figure 1a & 1b)

Pipe-based gravelless drainfields are currently available in two approaches: single-pipe, and multiple-pipe.

Single-pipe gravelless drainfields—

- Large diameter pipe is used (typically 8"-10" I.D., 10"-12" O.D.).
- The pipe is wrapped in a layer of geotextile material.
- The excavated trench is typically less than 24" wide (15"-18").
- Serial distribution (drop boxes or crossovers) is more commonly used than parallel distribution (distribution boxes).

Multiple-pipe gravelless drainfields—

- Medium diameter pipe is used (typically 4”- 4.5” O.D.)
- Pipe, in ten-foot lengths, is typically bundled in groups of 3 or 5 pipes.
- Bundles of pipe are grouped in various configurations to accommodate different widths and depths of trenches or beds.
- One of the pipes in the bundle is designed and designated for end-to-end connection to facilitate distribution of wastewater throughout the drainfield trench or bed.

Figure 1a. Typical Single-pipe Gravelless Drainfield, Cross-Section

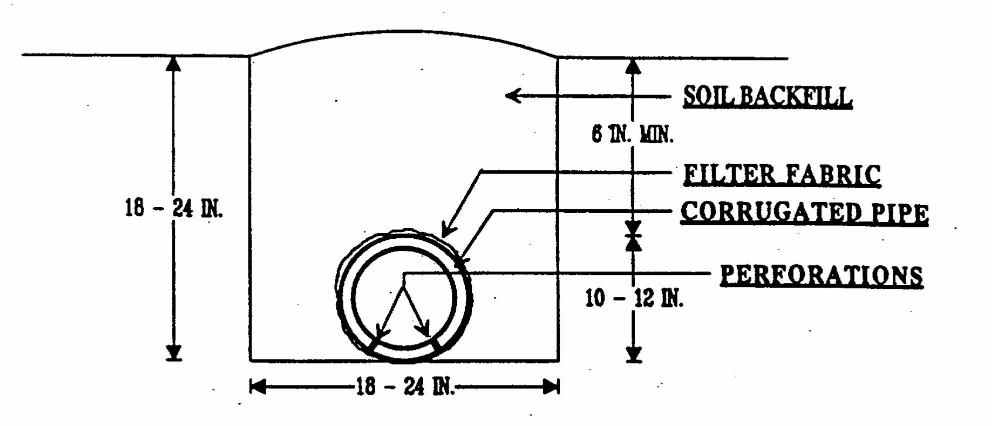
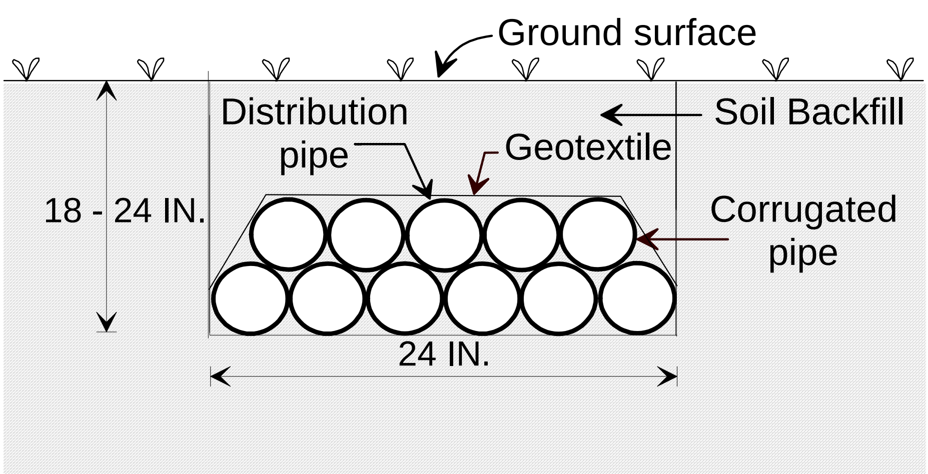


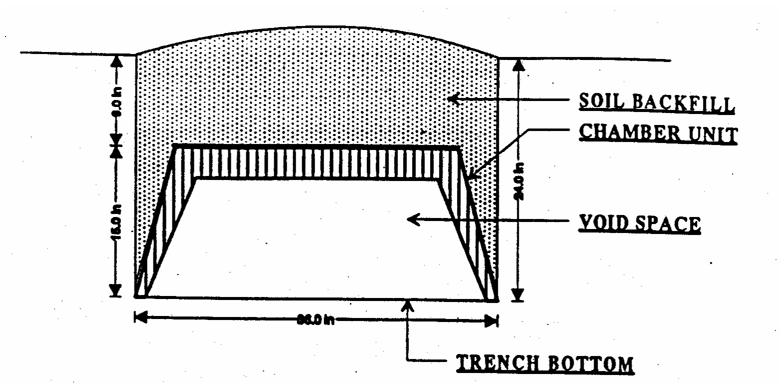
Figure 1b. Typical Multiple-pipe Gravelless Drainfield, Cross-Section



Gravelless Chambers—(See Figure 2)

- Molded chambers, of various dimensions, are used. The chambers replace the gravel-supported void space with chamber-supported void space. The trench, or bed, bottom infiltrative surface is fully exposed, sidewalls are generally louvered, and the top is generally solid.
- The chambers are placed, connected end-to-end, in the bottom of the trench (and placed side-by-side in a bed) and backfilled with native material (or as otherwise directed by the manufacturer depending upon soil conditions).
- At each end of each drainfield chamber line, solid end plates are installed for structural support and as a barrier to soil backfill.
- The use of a geotextile barrier between the chamber and the soil backfill varies from manufacturer-to-manufacturer, model-to-model (depending upon sidewall louver design), and depends on the type of soil in which the drainfield is installed.

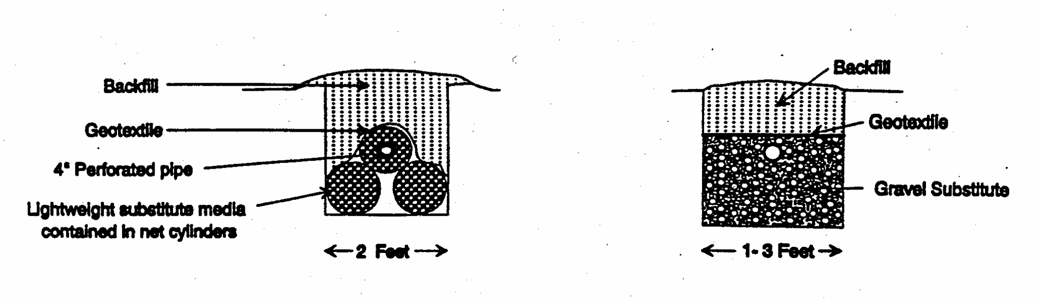
Figure 2. Typical Gravelless Chamber Drainfield, Cross-Section



Gravel-substitute—(See Figure 3)

- Of the different types of gravelless drainfields, gravel-substitute drainfields are the most similar to gravel-filled drainfields.
- Substitute media may be loose, or contained in netting for ease of installation and/or as an element of design.
- The particular shape and configuration of the substitute media may provide additional void space within the trench or bed depending on how the units are placed and the depth and width of the drainfield trench.
- A geotextile material is placed on top of the substitute media as a barrier to soil backfill infiltration. Some product manufacturers, due in part to the shape of their product, prefer the use of other types of barrier materials, such as 60 pound untreated building paper. In loose soils such as uniform sands non-deteriorating geotextile barrier material may be needed, however, to assure long-term protection. In either case, the manufacture's recommendations for assuring against soil backfill infiltration should be followed.

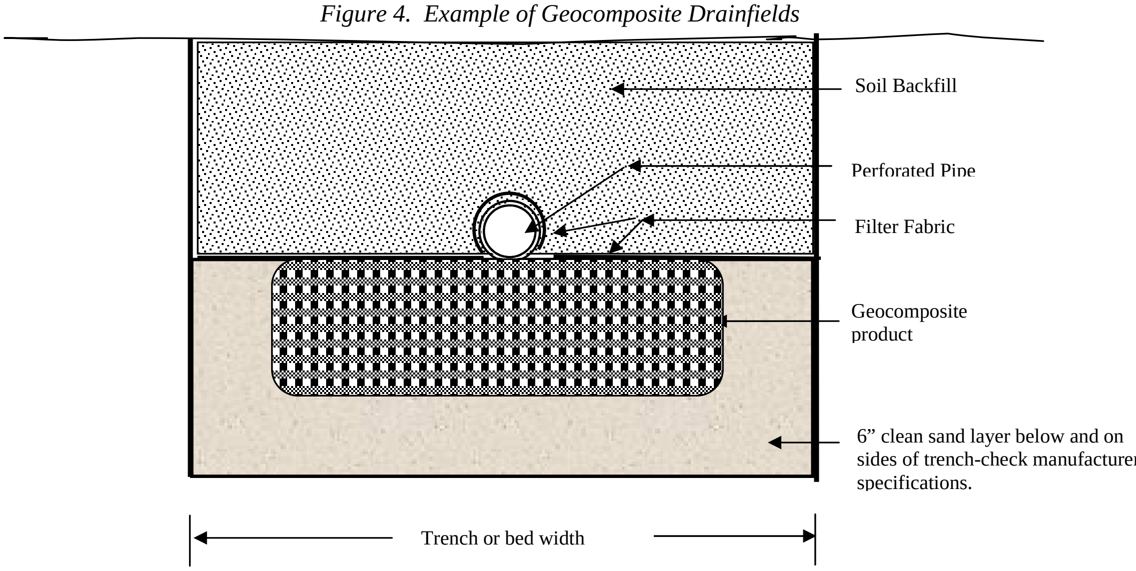
Figure 3. Examples of Gravel Substitute Drainfields



Geocomposites—(See Figure 4)

- Drainfield void space is created by the assembly of multiple layers of geogrid and geotextile bundled together in size and shape to facilitate handling and placement.
- Structural integrity is imparted by the design and material elements of the geocomposites.
- Geocomposite drainfields may incorporate a layer of sand media between the geogrid/geotextile bundle and the bottom and sides of the drainfield trench or bed.
- An effluent distribution pipe is placed on top of the geogrid / geotextile bundles.
- A geotextile material is placed on top of the geocomposite drainfield as a barrier to soil backfill infiltration.

Figure 4. Example of Geocomposite Drainfields



Performance Standards

1.1. Listing—

1.1.1. DOH reviews and lists proprietary gravelless drainfield products when the manufacturer or designated manufacturer representative demonstrates that the product meets or exceeds the performance criteria.

1.1.2. Before a local health jurisdiction may issue a permit for an on-site wastewater system incorporating a gravelless drainfield, the specific brand and model must be included on the current DOH List of Approved Systems and Products (WAC 246-272-04001(2)).

1.2. Performance Criteria—Gravelless drainfields must provide, at least equal to that provided by gravel in a conventional gravel-filled drainfield, the following attributes:

1.2.1. Non-decaying, non-deteriorating. Gravelless drainfield material must not decay, deteriorate, or leach chemicals or byproducts when exposed to sewage and the subsurface soil environment.

1.2.2. Void Capacity / Storage Volume. Must be established by drainfield materials, design, and installation; must be maintained for the life of the drainfield. This may be met on a lineal-foot, or on an overall drainfield-design, basis. The total measured void volume of any installed gravelless system must be equivalent to or greater than the void volume provided by a conventional gravel-filled trench system.

1.2.3. Infiltrative Surface Exposure. Must provide effluent distribution to the soil interface. Drainfield sizing in Washington State is based on trench, or bed, bottom area only. Sidewall is not considered, in terms of drainfield sizing, except where total annual recharge is less than 12 inches per year.

1.2.4. Maintenance of the trench or bed integrity. Material used, by its nature and its manufacturer-prescribed installation procedure must withstand the physical forces of the soil sidewalls and soil back-fill.

Drainfield Size & Long-term Performance—*An element of drainfield performance (gravel-filled and gravelless) is "life-span." The length of time a drainfield functions satisfactorily depends on many factors including:*

- *Accuracy of initial drainfield design, matching the site and soil characteristics to the anticipated facility use and wastewater generation.*
- *Quality of materials and methods used in the installation of the drainfield.*
- *Care of use (operation) and timeliness of maintenance on the system.*

While not addressed above as an element of the Performance Criteria, the selection of an appropriate wastewater-to-soil application rate is critical to the treatment performance of the drainfield and the length of time that treatment performance is achieved. Gravelless drainfield manufacturers commonly encourage the use of their products in reduced configurations when compared to conventional gravel-filled drainfields. While this approach may be satisfactory due to unique elements of the product designs, these smaller drainfields may impact the life of the drainfield. Drainfield performance over the long-term (20 – 30 years) needs to be observed and analyzed as additional field experience with these systems is gained.

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2. Application Standards—

2.1. Permitting—

2.1.1. Permitting and installation of gravelless drainfields are subject to local and state code.

2.1.2. Only proprietary gravelless drainfield products listed in the current edition of the DOH List of Approved Systems and Products may be permitted by local health jurisdictions (WAC 246-272-04001(2)). Only the specific models listed in the document are approved. If other models in a manufacturer's product-lines do not appear on the list, they are not approved for use in Washington State. If in doubt, contact DOH for current listing information.

2.1.3. Permit Requirements—The local health agency installation permit (and operational permit, depending on local code) must at least specify, among other items normally required within the specific local health jurisdiction, the following items:

- **(a)** The design flow volume (gallons/day) for the facility served.
- **(b)** The soil type (textural class number) at the site.
- **(c)** The soil application rate (gallons/sq. ft./day) matched to the soil type and conditions.
- **(d)** The drainfield size required (square feet) if a conventional gravel-filled drainfield were to be used.
- **(e)** The size of the proposed gravelless drainfield (square feet) with % reduction, if used.
- **(f)** The frequency of gravelless drainfield status observations.
- **(g)** The requirements for drainfield expansion, repair, or replacement in event of observed problems. (See Section 4.3 for possible outcomes of observed ponding conditions.)

2.2. General Conditions—Gravelless drainfields may be used:

2.2.1. In applications and locations where soil and other site conditions are suitable for a conventional septic tank and drainfield system.

2.2.2. In conjunction with approved treatment systems, such as sand filters or aerobic treatment units, that may provide effluent quality sufficient for gravelless drainfields to be used on sites not otherwise suitable for a conventional septic tank and drainfield.

2.2.3. Where soil types and depths, setbacks, and other site evaluation and location requirements found in subsections -11001, -20501, and -09501 of WAC 246-272 are satisfactorily met.

2.2.4. Incorporating any combination of the following design elements:

- **(a)** gravity-flow distribution;
- **(b)** pressurized distribution;
- **(c)** drainfield dosing; and,
- **(d)** alternating drainfields.

2.2.5. In mounds and sand filters (and, when recommended standards and guidance is approved by DOH, in at-grade systems) in lieu of gravel-filled trenches or beds.

2.3. Soil Conditions—

2.3.1. Gravelless drainfields may be used in Soil Type 1A provided that the wastewater receives treatment at least equal to Treatment Standard 2 prior to discharge to the soil for final treatment and disposal. This may be accomplished by using the gravelless drainfield in a sand-lined drainfield trench with a minimum of 24" of sand media as detailed in the DOH Recommended Standards and Guidance for Sand Filters.

2.3.2. In Soil Types 4, 5, and 6, gravelless drainfields must be used in a trench configuration only: not to be used side-by-side in a bed. In Soil Types 1A, 1B, 2A, 2B and 3, gravelless drainfields may be used in a bed configuration with a maximum bed width of 10 feet. (Note: these restrictions also apply to gravel-filled drainfields.)

2.4. Minimum Land Area / Drainfield Area Requirements—

2.4.1. The use of a gravelless drainfield does not provide for a reduction in the minimum land area requirements established in WAC 246-272-20501. Site development incorporating gravelless drainfields must meet the minimum land area requirements established in state and local codes.

2.4.2. The drainfield area proposed for an on-site sewage system using gravelless drainfield products <u>must</u> provide for each drainfield (the initial and replacement) an area equal to 100% the size of a gravel-filled drainfield.

2.5. Influent Wastewater Characteristics—

2.5.1. Wastewater from residential sources must receive pre-treatment at least equal to that provided in a conventional two-compartment septic tank, before discharge to a gravelless drainfield.

2.5.2. Wastewater from non-residential sources, or high-strength wastewater from residential sources must receive pre-treatment sufficient to lower the waste-strength to the level of that commonly found in domestic residential septic tank effluent before discharge to a gravelless drainfield.

2.6. Installation—Gravelless drainfields must be installed according to the manufacturer's instructions, in a manner that is consistent with these standards, state and local rules. If the manufacturer's instructions and these standards are in conflict, the matter must be discussed with, and decided by, the local health officer.

3. Design Standards / Proprietary Products—

Gravelless drainfield technologies are, for the most part, proprietary. As such, other than the Performance Criteria identified in Section 1.2, there are few specific design requirements for the manufactured products. There are, however, Design Standards relative to:

- the required vertical separation and the method of wastewater distribution;
- certain soil types and required use of pressure distribution;
- certain soil types and pre-treatment to levels meeting Treatment Standard 2;
- the minimum depth of gravelless drainfield trench;
- the size of the gravelless drainfield

3.1. Specifications for gravel-substitute media:

3.1.1. Gravel substitute media must be in the same size range as gravel (3/4" to 2½").

3.1.2. The gravel substitute must provide:

(a) a minimum 30% void volume under compression conditions encountered in a soil trench; and,

(b) total void volume per square foot of trench bottom equivalent to, or greater than, that in a gravel-filled trench.

(c) See Appendix C, Table 1 for void volume of conventional gravel-filled drainfield trenches. In jurisdictions where more than 12 inches of gravel depth is required, additional calculation may be necessary to assure comparable void volume.

3.2. Vertical Separation—Varies depending on method of effluent distribution.

3.2.1. With gravity-flow distribution, a minimum of three feet of vertical separation must be established by design and maintained by installation.

3.2.2. With pressure distribution, a minimum of two feet of vertical separation must be established by design and maintained by installation.

3.3. Pressure Distribution Required—Pressure distribution is required in Soil Types 1A and 2A (Table IV, WAC 246-272-11501).

3.4. Treatment Standard 2 Pre-treatment Required—Wastewater pre-treatment to levels meeting or exceeding the Treatment Standard 2 must be included in on-site sewage system designs using gravelless drainfields in Soil Type 1A, and in Soil Types 1B, 2A, 2B, 3 through 6 where the vertical separation is between 1 foot and 2 feet.

3.5. Drainfield Depth—Gravelless drainfields must be installed at a minimum depth of 6 inches into original, undisturbed soil.

3.6. Drainfield sizing—Drainfield sizing in Washington State is based on trench, or bed, bottom area only, except where total annual recharge is less than 12 inches per year. Sidewall infiltration, while it is an acknowledged element of drainfield function, is not considered in terms of drainfield sizing.

3.6.1. Determine the amount of conventional drainfield required by dividing the daily design flow (in gallons) by the application rate, which varies according to Soil Type (See WAC 246-272-11501).

3.6.2. Once the drainfield area required is determined (square feet of trench or bed bottom area) the length of drainfield can be determined. The lineal amount of gravelless drainfield product required to provide the total drainfield area depends on the amount of bottom area infiltrative surface area per lineal foot provided by the gravelless drainfield product.

To determine the total length of drainfield required divide the total square footage of drainfield required by the amount of infiltrative area per lineal foot of the type of drainfield material selected.

For the purpose of drainfield sizing:

☑ **Single-pipe gravelless drainfields**—The infiltrative area per lineal foot of pipe is calculated based upon the outside diameter of the pipe.

☑ **Multiple-pipe gravelless drainfields**—The infiltrative area per lineal foot of pipe is calculated based upon the outside dimensional width of the pipe bundle(s) in contact with the bottom of the trench or bed.

☑ **Gravelless chamber drainfields / Sizing Standard**—The infiltrative area per lineal foot of chamber is calculated based upon the outside dimensional width of the chamber in contact with the bottom of the trench or bed.

- **Sizing Alternative A (More conservative than the Sizing Standard)**: The infiltrative area per lineal foot of chamber is based upon the actual exposed interior dimensional width of the chamber at the trench or bed bottom, not the exterior dimension, nominal size or product marketing description.
- **Sizing Alternative B (Less conservative than the Sizing Standard)**: The infiltrative area per lineal foot of chamber is calculated based on the bottom width of trench or bed. The outside dimensional width of the chamber in contact with the bottom of the trench or bed must measure at least 90% of the trench or bed width. See table, below.

For sizing based on a trench width of (inches)	The measured width of the chamber at the bottom of the trench must be at least (inches)
36	32.4
30	27.0
24	21.6
18	16.2
12	10.8

- ☑ **Gravel substitute drainfields—**The infiltrative surface area per lineal foot of gravel substitute is equal to the width of bottom of the trench or bed covered by the gravel substitute.
- ☑ **Geocomposite drainfields—**The infiltrative area per lineal foot of geocomposite is equal to the outside dimensions of the bundle(s) in contact with the bottom of the trench or bed. If a sand layer is required between the geocomposite and the infiltrative surface at the bottom of the trench or bed, by the manufacturer, the infiltrative area per lineal foot is equal to the outside bottom dimensions of the bundle(s) in contact with the sand layer.

Gravelless Chamber Drainfield Sizing—

The sizing criteria for gravelless drainfields, along with the two Options presented in Section 3.6.2 represent the range of sizing approaches considered and endorsed by the TRC since Fall 2002. The information about the TRC discussions and recommendations presented below is provided to assist LHJs identify which approach is most appropriate for their jurisdictional area, climate, soils, and application. During this time the TRC reviewed previously adopted positions and considered new proposals from the industry for sizing chamber drainfields. In an arena where the discussion can degrade to "dueling research study results" the TRC shifted the focus of their deliberation over time. Early evaluation of chamber technology and the supporting science resulted in sizing criteria based on exposed open bottom area, the predominate technical justification for reducing the size of gravelless chamber systems. Later evaluation integrated real-world experience (how are systems actually being sized?) and simple practical matters for sizing and installing chamber systems.

From the sizing standard and two sizing alternatives, LHJs may establish the sizing criterion that is best for their jurisdiction. Jurisdictions may choose to apply the sizing standard presented in 3.6 Drainfield Sizing, concluding that sizing gravelless chamber drainfields on the external dimension of the chamber may be the best approach, balancing the primary technical merit of chambers (open area) with the ease of identifying trench bottom infiltrative area by simple measure of the external width dimension. Or they may choose the more conservative Alternative A recalling that the allowance of drainfield size reductions for gravelless chamber systems rests with the manufacturer-described technical merit of unobstructed infiltrative surface exposure on the trench bottom under the interior of the chamber. Or, LHJs may choose the less conservative Alternative B acknowledging the amount of exposed trench bottom surface area provided compared to standard gravel-filled trenches. Local jurisdictions may freely establish the sizing criteria for gravelless chamber drainfields appropriate for their jurisdiction.

TRC Evaluation of Gravelless Chamber Drainfield Sizing Criteria—

During the October 2002 TRC meeting the TRC reviewed the sizing criteria for gravelless chambers. The purpose for this review was to clarify the perceived discrepancy between the sizing criteria in the RS&G for gravelless drainfield systems and the product specific dimensional information provided in the List of Approved Systems and Products. The section of the listing document that relates to gravelless drainfield products presents sizing information based on the external dimension of chambers, not the actual exposed interior dimension.

By unanimous vote the committee reaffirmed and clarified their position on the sizing of gravelless chamber drainfields by modifying the sizing criteria statement in the RS&G for gravelless drainfield systems to read:

"**Gravelless chamber drainfields—**Calculate the required length of chamber using the effective area for the particular chamber. The effective area per lineal foot of chamber is based upon the actual exposed interior dimensional width of the chamber at the trench or bed bottom, not the nominal size or product marketing description."

While the DOH was preparing to amend and distribute the RS&G with the clarifying language, Infiltrator Systems, Inc. requested that the department delay such action until after the Rule Development Committee (RDC) had an opportunity to address sizing criteria for gravelless drainfields and drainfield size reductions in the rule development process. The DOH agreed to the Infiltrator Systems, Inc. request. The RDC did address the matter of drainfield size reductions and gravelless drainfield sizing by recommending that these matters not be addressed in rule, but rather be retained in the RS&G for gravelless drainfields. With that decision by the RDC the DOH reinitiated action in early spring 2004 to implement the October 2002 recommendation of the TRC.

At the April 2004 TRC meeting the committee discussed a sizing proposal submitted by Infiltrator Systems, Inc. to size all systems according to the width of the trench provided that the width of the gravelless product is at least 90% of the width of the trench. The TRC, following presentations of opposing viewpoints by Infiltrator Systems, Inc. and Ring Corporation / EZflow, recommended to the department that gravelless systems be sized according to bottom width of the trench or bed.

At the June 2004 TRC meeting DOH staff explored the implementation of the April 2004 recommendation for gravelless drainfield system sizing, expressing concerns for the potential complexity resulting from the granting of sizing credit beyond the measured width of the gravelless drainfield product. Following committee discussion that provided opportunity for gravelless drainfield industry representatives to comment, the TRC refined their recommendation for sizing based on trench width to apply only to gravelless chamber systems, and recommended that the department incorporate this sizing criteria in the RS&G for gravelless drainfields. The language presented above in the Subsection 3.6 of the Recommended Standards and these guidance comments represents the department's approach to implementing the recommendations of the TRC relating to gravelless chamber drainfield sizing.

Product Manufacturer / System Designer Responsibilities—*When gravelless drainfield manufacturers promote, and on-site sewage system designers integrate in their client's sewage systems, reduced-size drainfields they share with the system owner the responsibility for satisfactory long-term function of the drainfield. It is not necessarily acceptable design practice to apply reduced-size gravelless drainfields in all soils, sites, or applications simply because the manufacturer's literature suggests, or the local and state minimum codes may allow, use of gravelless drainfield technologies in this manner.*

3.6.3. Reduced drainfield sizing criteria for gravelless drainfields—Gravelless drainfield products provide identifiable benefits compared to gravel and other mineral rock materials. Generally, the light-weight, low-impact nature of gravelless drainfield materials combined with the absence of mineral fines frequently associated with mineral sources of drainfield gravel, contribute to less damage to the infiltrative surface when gravelless drainfield products are installed and used,

In response to these general attributes, as well as specific design attributes of various types of gravelless drainfield products, the option to reduce installed drainfield size is extended to the following types of gravelless drainfield products:

- ❑ Chamber drainfields

- Gravel-substitute drainfields
- Geo-composite drainfields

With 100% of the area required for a gravel-filled drainfield established and dedicated (for initial and replacement fields) reduced-size gravelless drainfields may be designed and installed. System design, layout, and installation must be done in a manner easily facilitating the installation of additional gravelless drainfield if future conditions necessitate such action. For systems using pressure distribution, if additional drainfield is needed in the future, elements of the system (such as the pump or controls) may need to be modified in order to meet the hydraulic performance requirements of pressure distribution throughout the expanded drainfield system.

(a) Drainfield size reductions allowed varies according to soil types, as follows:

- ☑ Soil Types 1A, 1B: No Reduction Allowed
- ☑ Soil Types 2A , 2B: Up to 20% Reduction Allowed
- ☑ Soil Types 3 through 6: Up to 40% Reduction Allowed, except in soils with appreciable amounts of expandable clay (See Appendix A), where no reduction is allowed.

(b) Observation Ports—Must be installed in a representative location on each drainfield line. Some drainfield lines may require additional observation ports to achieve observations representative of the entire drainfield line. Specific information about observation ports is available in the text box following item 4.1.2.

(c) Drainfield size reduction must not exceed the manufacturer's sizing recommendation.

3.6.4. Combining Drainfield Size Reduction Allowances—Drainfield size reductions for gravelless drainfield products may not be combined with drainfield size reductions based on effluent quality.

Until more long-term experience applying reduced-size gravelless drainfields is gained, it remains imperative that long-term drainfield function and public health protection is assured by implementing the following:

- *Full drainfield areas for the initial and replacement area (providing full suitable area for expansion and replacement of the drainfield if needed.*
- *Strategically placed observation ports in each drainfield line to observe the infiltrative surface conditions and ponding levels within the drainfield.*
- *Regular observation of the drainfield to assure timely identification of pending problems in a timeframe that allows corrective action before public health is placed at risk due to a drainfield failure.*
- *System owner awareness of the potential for size-related drainfield issues, both in terms of needed diligence to Operation and Maintenance (O&M) and cost-of-repair issues.*
- *When choices are made regarding what type of drainfields to install, and how much drainfield to install, the choices must be well considered, intentional decisions made by both the designer and the on-site sewage system owner.*

3.6.5. Other Design Elements—Other design features, such as trench separation, maximum lateral lengths, vertical separation, maximum width and depth of trench, minimum depth of soil backfill, suitable backfill, required pretreatment, setbacks, etc., must be the same as for conventional drainfields. (See Chapter 246-272 WAC)

4. Operation and Maintenance Standards—

4.1. General—

4.1.1. The owner of the residence or facility served by the gravelless drainfield is responsible for assuring proper operation and providing timely maintenance for all components of the on-site wastewater treatment and disposal system.

4.1.2. The on-site wastewater system designer must instruct, or assure that instruction is provided to, the owner of the residence or facility regarding proper operation of the entire on-site wastewater system.

Observation Ports—*The installation of observation ports in on-site sewage system drainfields is encouraged for the purpose of monitoring system status and aiding in problem analysis. To be effective they must be installed in a representative location on <u>each</u> drainfield line. Some drainfield lines may require additional observation ports to observe conditions representative of the entire drainfield line.*

Well-designed and installed observation ports:

- *Extend to at least the ground surface of the final landscape grade.*
- *Are firmly anchored so as to prohibit unauthorized removal.*
- *Are accessible for routine observation.*
- *Are secured or otherwise protected from accidental or unauthorized access.*
- *Provide visual access to the trench-bottom in the gravel portion of a gravel-filled drainfield and, in gravelless drainfields:*
  - ☑ *Single-Pipe: to the interior of the pipe.*
  - ☑ *Multiple-Pipe: to the infiltrative surface.*
  - ☑ *Chamber: to the interior of the chamber.*
  - ☑ *Gravel Substitute: to the infiltrative surface.*
  - ☑ *Geocomposite: to the infiltrative surface.*

4.2. O&M activities include—

4.2.1. Assuring that no surface water collects on the drainfield site.

4.2.2. Prohibiting any type of vehicular or livestock traffic over the drainfield area.

4.2.3. Maintaining a suitable, non-invasive shallow-rooted vegetative cover over the drainfield site.

4.2.4. Observing the entire on-site sewage system at a frequency appropriate for the site conditions and the on-site sewage system. This may be done by the homeowner or other persons, as appropriate.

4.2.5. Maintaining a written chronological record of drainfield ponding level observations, and operation and maintenance activities. If the system uses pressure distribution or other means of system dosing, the person monitoring the system needs to be aware of the impact of dose frequency on observed ponding levels.

4.2.6. Servicing all system components as needed, including product manufacturer's requirements / recommendations for service.

The frequency of observing on-site sewage system conditions and the level of detail of information that is retained by the system owner and/or reported to the local health jurisdiction relates to risk presented by site conditions and system complexity. Monitoring and reporting to assure proper function becomes *increasingly critical for more vulnerable sites and/or complex systems. Table 3 and Table 4 illustrate this concept and may be used to guide decisions related to observing and reporting.*

Table 3. Relationship of Site Risk and System Complexity

Issue	Characteristics / Level of Risk		
	Lower Risk ← ← ← ← ← ← ← ← ← ← ←		→ → → → → → → → → → → Higher Risk
Site Risk	Meets state rules for *conventional gravity system*	Meets state rules for *conventional pressure distribution system*	**Risk increases with -** *less* vertical separation, smaller lot sizes, less horizontal separation, and, *greater surface* slope, wastewater flow, wastewater strength, etc.
System Complexity	Gravity-flow (no pumps, controls, etc.)	Pressurized distribution (requires pumps & controls)	**Complexity increases with -** *increasing* reliance upon, or combinations of: pumps; blowers; motors; mechanical, electronic, or computer-operated controls & warning devices; disinfection (materials & equipment); quality control of artificial (non-original soil) treatment media, etc.

Table 4. Suggested Monitoring Frequency Based On Risk and Complexity

	Level			
Site Risk	Low	Low	High	High
System Complexity	Low	High	Low	High
Monitoring Frequency	***Low = Annually***	***Medium = Semi-annually***		***High = Quarterly, or greater***

4.3. Observed Conditions / Actions—

4.3.1. When observation reveals either of the following listed conditions, the owner of the system must take appropriate action to alleviate the situation according to the direction and satisfaction of the local health officer.

- **(a)** Drainfield failure; or,
- **(b)** A history of long-term, continuous and increasing ponding of wastewater within the gravelless drainfield of such magnitude that if left unresolved, will probably result in drainfield failure.

4.3.2. Appropriate action may include:

- **(a)** Repair or modification of the drainfield.
- **(b)** Expansion of the drainfield.
- **(c)** Modifications or changes within the structure relative to wastewater strength or hydraulic flow.
- **(d)** For on-site sewage systems where a reduced-size gravelless drainfield was used, the repair or modification required may include the installation of additional gravelless drainfield units to enlarge the drainfield to 100% of the initial (gravel-filled) design size.

Local permits must be obtained before construction begins, according to local health department requirements.

Appendix A

Identifying Soil With Expanding Clay

Please Note: *The following information has been provided by Lisa Palazzi to address the issue of appreciable amounts of expandable clay. Ms. Palazzi is a private-sector soil scientist and a former member of the department's Technical Review Committee.*

A Vertisol is one of the 11 Taxonomic Soil Orders, and is defined as having slickensides (smeared planes within the soil profile) at least 10 inches thick within the top 40 inches of soil, and having 30% clay content and having cracks that open and close periodically. The slickensides and cracks imply that the clay content is primarily expanding clays, as those features occur concurrently only with expanding clays. Vertisols are identified in general textbooks as being generally incapable of supporting septic drainfields, although many septic systems are installed and functioning in Texas Vertisols. This success however, is thought to be a result of their very low rainfall climate.

Expanding clays - such as montmorillonite or smectite or bentonite - can be defined on a mineralogic level as being composed of a 2:1 alumino-silicate crystalline lattice, as compared to non-expanding clays - such as kaolinite (the red Georgia clays) - which have a 1:1 crystal lattice form. From a more practical perspective, they can be defined by a measurement of how much they shrink when taken from a saturated water content to a dry water content. That measurement is called a Coefficient of Linear Extensibility (COLE) and a 9% change is considered definitive of having a significant montmorillonite content. At another scale, the distance between two montmorillonite crystal lattices when dry is reported as being 9.6 angstroms; and when exposed to 50% relative humidity, expanding to 10's or even hundreds of angstroms. So it is obvious that even a very small amount of expanding clay can have a huge effect on soil drainage characteristics. 5-10% content could be considered "appreciable".

It is important to note that there are few areas with expanding clays north of the terminus of the continental glacier (about Tenino for western Washington). Areas south of that however could have some Vertisols, although they are not terribly common. If we need a measure of expansion potential, the COLE process could be applied with fairly simple tools. One simply mixes a soil/water solution to the point where the clay soil is almost saturated, but can still be formed into a "worm" or rod-shaped lump. The length of the rod is measured. Then the rod is placed in an oven to dry (250 degrees for about an hour should be enough), then re-measured. If the length of the rod decreases by more than 3-5%, there is probably enough expanding clay to affect soil drainage potential. I chose 3-5% somewhat arbitrarily mainly because it is about one third to one half that of that used to indicate significant content of montmorillonite (9%).

Appendix B

Definitions

Alternative System: *an on-site sewage system other than a conventional gravity system or conventional pressure distribution system. Properly and maintained alternative systems provide equivalent or enhanced treatment performance as compared to conventional gravity systems.*

Approved List: *"List of Approved Systems and Products", developed annually and maintained by the department and containing the following:*

(a) List of proprietary devices approved by the department;
(b) List of specific systems meeting Treatment Standard 1 and Treatment Standard 2;
(c) List of experimental systems approved by the department;
(d) List of septic tanks, pump chambers, and holding tanks approved by the department.

Conventional Gravity System: *an on-site sewage system consisting of a septic tank and a subsurface soil absorption system with gravity flow distribution of the effluent.*

Disposal Component: *a subsurface absorption system (SSAS) or other soil absorption system receiving septic tank or other pretreatment device and transmitting it into original, undisturbed soil.*

Drainfield (conventional): *an area in which perforated piping is laid in drain rock-packed trenches, or excavations (seepage beds) for the purpose of distributing the effluent from a wastewater treatment unit.*

Effluent: *wastewater discharged from a septic tank or other on-site sewage system component.*

Experimental System: *any alternative system without design guidelines developed by the department or a proprietary device or method which has not yet been evaluated and approved by the department.*

Failure: *a condition of an on-site sewage system that threatens the public health by inadequately treating sewage or creating a potential for direct or indirect contact between sewage and the public. Examples of failure include:*

(a) Sewage on the surface of the ground;
(b) Sewage backing up into a structure caused by slow absorption of septic tank effluent;
(c) Sewage leaking from a septic tank, pump chamber, holding tank, or collection system;
(d) Cesspool or seepage pits where evidence of ground water or surface water quality degradation exists; or
(e) Inadequately treated effluent contaminating ground water or surface water.
(f) Noncompliance with standards stipulated on the permit.

Final Treatment/Disposal Unit: *that portion of an on-site sewage system designed to provide final treatment and disposal of the effluent from a wastewater treatment unit, including, but not limited to, absorption fields (drainfields), sand mounds and sand-lined trenches.*

Infiltrative Surface: *in drainfields, the drain rock-original soil interface at the bottom of the trench; in mound systems, the gravel-mound sand and the sand-original soil interfaces; in sand-lined trenches/beds (sand filter), the gravel-sand interface and the sand-original soil interface at the bottom of the trench or bed.*

Influent: *wastewater, partially or completely treated, or in its natural state (raw wastewater), flowing into a reservoir, tank, treatment unit, or disposal unit.*

On-site Sewage System: *an integrated arrangement of components for a residence, building, industrial establishment or other places not connected to a public sewer system which:*
(a) Convey, store, treat, and/or provide subsurface soil treatment and disposal on the property where it originates, upon adjacent or nearby property; and
(b) Includes piping, treatment devices, other accessories, and soil underlying the disposal component of the initial and reserve areas.

Proprietary Device or Method: *a device, or method classified as an alternative system, or a component thereof, held under a patent, trademark or copyright.*

Residential Sewage: *sewage having the consistency and strength typical of wastewater from domestic households.*

Septic Tank: *a watertight pretreatment receptacle receiving the discharge of sewage from a building sewer or sewers, designed and constructed to permit separation of settleable and floating solids from the liquid, detention and anaerobic digestion of the organic matter, prior to discharge of the liquid.*

Sewage: *any urine, feces, and the water carrying human wastes including kitchen, bath, and laundry wastes from residences, building, industrial establishments or other places. For the purposes of these guidelines, "sewage" is generally synonymous with domestic wastewater. Also see "residential sewage."*

Treatment Component: *a class of on-site sewage system components that modify and/or treat sewage or effluent prior to the effluent being transmitted to another treatment component or a disposal component. Treatment occurs by a variety of physical, chemical, and/or biological means. Constituents of sewage or effluent may be removed or reduced in concentrations.*

Treatment Standard 1: *A thirty-day average of less than 10 mg/l of BOD_5 and 10 mg/l of total suspended solids and a thirty-day geometric mean of less than 200 fecal coliform/100ml.*

Treatment Standard 2: *A thirty-day average of less than 10 mg/l of BOD_5 and 10 mg/l of total suspended solids and a thirty-day geometric mean of less than 800 fecal coliform/100ml.*

Vertical Separation: *the depth of unsaturated, original, undisturbed soil of Soil types 1B - 6 between the bottom of a disposal component and the highest seasonal water table, a restrictive layer, or Soil Type 1A.*

Wastewater: *water-carried human excreta and/or domestic waste from residences, buildings, industrial establishments or other facilities. (See SEWAGE.)*

Wastewater Design Flow: *the volume of wastewater predicted to be generated by occupants of a structure. For residential dwellings, this volume is calculated by multiplying the number of bedrooms by the estimated number of gallons per day (GPD), using either the minimum state design standard (120 GPD) or the locally established minimum standard (such as 150 GPD).*

Appendix C

Conventional Gravel-Filled Drainfields / Void Space and Infiltrative Surface Area—

Conventional gravel-filled drainfields typically consist of a level trench (3 ft. wide) or bed (>3 ft. <10 ft. wide) with 6 to 12 inches of gravel placed on the bottom. A gravity flow distribution network consisting of 4-inch diameter perforated plastic pipe is located on this layer of gravel. Additional gravel is placed over the pipe to a level 2 inches above the pipe. The gravel is then covered with a layer of geotextile material and the trench is backfilled with native soil material.

Conventional gravel-filled drainfields are sized according to trench (or bed) bottom area only. The treatment and disposal contribution of the trench sidewall is acknowledged, but is not considered for drainfield sizing. This conservative approach to drainfield sizing provides a prudent margin of error when designing soil-treatment and disposal-based on-site sewage systems. For base-line design purposes the void space and infiltrative surface area of a conventional gravity flow gravel-filled drainfield trench with a 1-foot depth of gravel and a 4-inch diameter distribution pipe is presented in Table 1 and Table 2.

Table 1. Void Volume in a One-Foot Length of Conventional Gravel-filled Drainfield Trench

Drainfield Trench (gravel portion)	Volume (Gross) V_g (in ft^3)	Volume (4.5" O.D. Pipe) $V_{4.5"}$ (in ft^3)	Volume (Net) $V_N = V_g – V_{4.5"}$ (in ft^3)	% Void Volume $VV_{\%}$ (in ft^3)	Total Void Volume $VV_T = V_N$ x $V_{\%} + V_{4.5"}$ (in ft^3)
12" (H) x 30" (W) x 12"(L)	1' x 2.5' x 1' = 2.5	(Ξr^2 x 12") / 1728 = .11	2.39	(washed drainrock) at least.30	2.39 x .30 + .11 = .83
12" (H) x 36" (W) x 12"(L)	1' x 3' x 1' = 3	(Ξr^2 x 12") / 1728 = .11	2.89	(washed drainrock) at least.30	2.89 x .30 + .11 = .98

Table 2. Infiltrative Surface in a One-Foot Length of Conventional Gravel-filled Drainfield Trench

Drainfield Trench (gravel portion)	Infiltrative Surface Per Lineal Foot of Trench	
	Bottom Area Only (WAC 246-272-11501(2)(I)	Bottom Area + 6" sidewall* (WAC 246-272-11501(4)(e).
12" (H) x 30" (W) x 12"(L)	Two & one-half (2.5) square feet	Three & one-half (3.5) square feet
12" (H) x 36" (W) x 12"(L)	Three (3) square feet	Four (4) square feet

WAC 246-272-11501(4)(e): The local health officer or department may allow the hydraulic loading rate calculated for the infiltration surface area in a disposal component to include six (6) inches of the SSAS sidewall height for determining design flow where total recharge by annual precipitation and irrigation is less than twelve (12) inches per year.